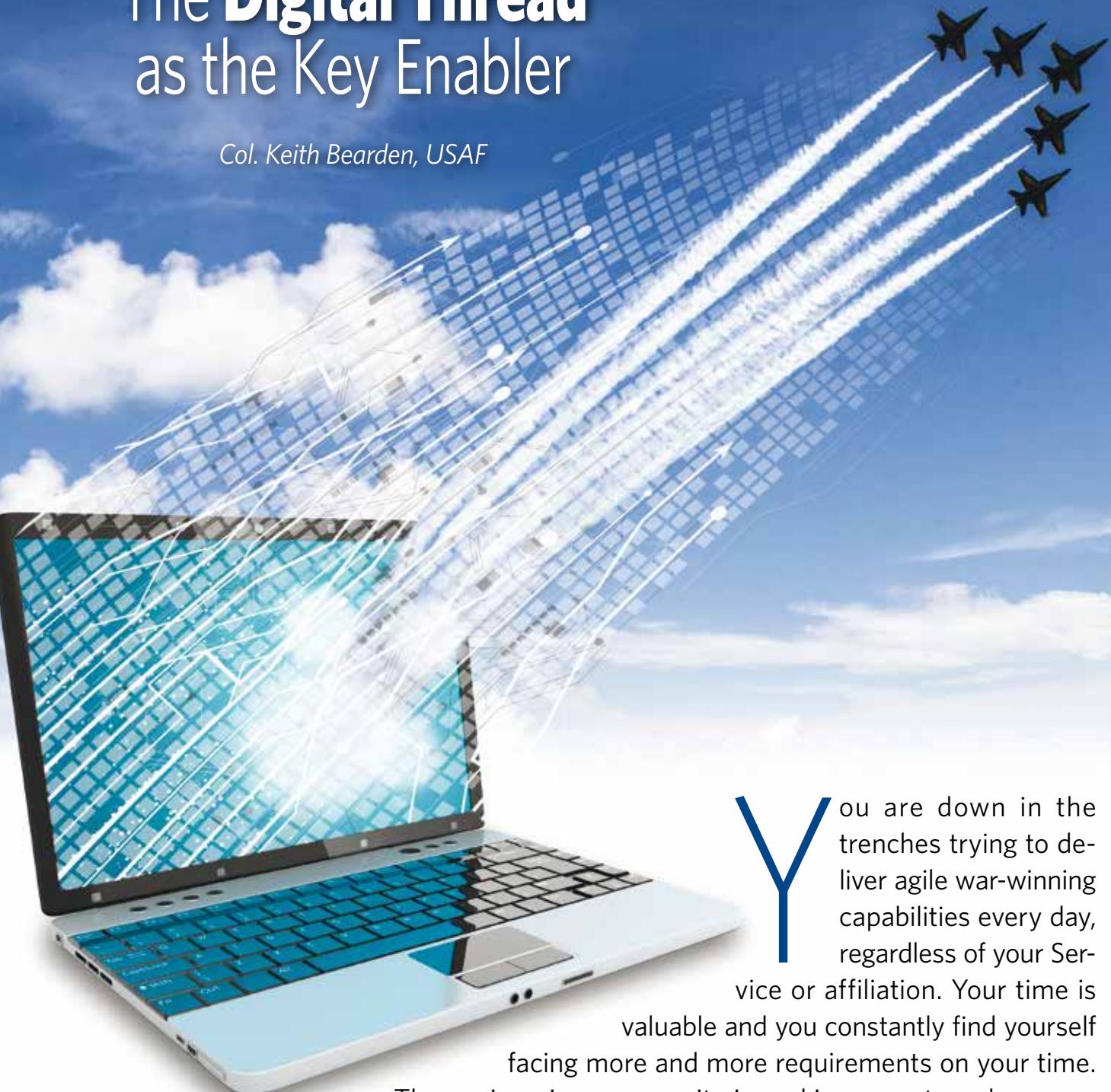


The Digital Thread as the Key Enabler

Col. Keith Bearden, USAF



You are down in the trenches trying to deliver agile war-winning capabilities every day, regardless of your Service or affiliation. Your time is valuable and you constantly find yourself facing more and more requirements on your time.

The engineering community is seeking ways to reduce your workload while at the same time enabling you to do your job better, faster and cheaper. There is one initiative, the key enabler, to accomplish this goal—the digital thread. But let's set the stage first.

The 2013 *Global Horizons* report was the forcing function that kicked off a massive change in the U.S. Air Force. *Global Horizons* specifically challenged the Air Force and our science and engineering workforce to:

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- Investigate and institutionalize digital engineering to reduce development cycle time.
- Develop and institutionalize a re-engineered prototyping and experimentation process that would allow for rapid cross-domain analysis and technology transition prior to bending metal.
- Re-establish a culture of “hands-on” engineering that allows the Air Force to restore technical prominence and recruit and retain the best and brightest from our academic institutions.
- Implement advanced manufacturing techniques, including additive manufacturing (AM) for enabling part optimization unburdened by the restraints of traditional manufacturing techniques and ensuring just-in-time parts availability.

All this will require process qualification and certification as opposed to part qualification and certification.

This visionary work detailed what the Air Force must do to recapture organic engineering excellence and continued technological superiority. Of course, this vision will require a change in culture in order to succeed. Fortunately, this work was not simply put on the shelf to collect dust. The Air Force acted on it.

The Department of Defense (DoD) and the Air Force issued game-changing strategic guidance in 2014 and 2015 following *Global Horizons 13*. Have you read the guidance from the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD[AT&L]) on Better Buying 3.0? Have you read *America's Air Force-A Call to the Future*, our 30-year vision, or the *USAF Strategic Master Plan*, our 20-year plan to achieve the vision or the recently published *Air Force Future Operating Concept*? For the first time in memory, these revolutionary documents specifically impose requirements on the research and acquisition communities as well as the operational community.

Let's begin with the central idea of operational agility, “the ability to rapidly generate—and shift among—multiple solutions for a given challenge.” In the past, our systems were conceived and designed as “exquisite platforms.” In the future,

we will need to rapidly flex between multiple options overwhelming our adversary's ability to counter. This ultimately will provide a dynamic form of resilience. It will be the responsibility of the research and acquisition communities to provide solutions that have this inherent flexibility and interoperability. We need to deliver the ability to assess capabilities across multi-domain operations, ensure superior decision speed unencumbered by classification barriers through our technical solutions, and provide a method to investigate a balanced capabilities mix and performance-optimized teams.

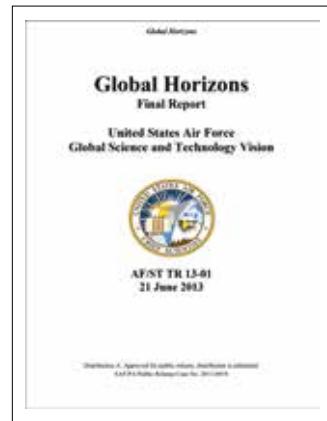
The *Future Operating Concept* provides high-level descriptions of these agility concepts

but the bottom line is that our scientists and engineers will have to determine how to bring this vision to fruition. The good news is that our leadership understands this will require a change in the institutional culture. “An acquisition and logistics enterprise that is capable of rapidly identifying, acquiring, and fielding solutions through organic

additive manufacturing or commercial off-the-shelf sources ... and technology development using live, virtual and constructive (LVC) venues to enable the conservation of resources, improve the realism of training for combat and multi-domain challenges, and facilitate the development of innovative and collaborative solutions.”

The *USAF Strategic Master Plan* takes these overarching goals one step further, demanding the research and acquisition communities embrace a capability development process that is agile, adaptable and responsive in delivering affordable and mission-effective capabilities. It challenges the research and acquisition communities to:

- Pursue modular, adaptable and reconfigurable solutions.
- Have the Air Force perform as the integrator at both the platform and enterprise level.
- Empower the Air Force to demand an agile acquisition enterprise that can balance cost, capability and schedule and can incentivize innovation in competitive solutions.

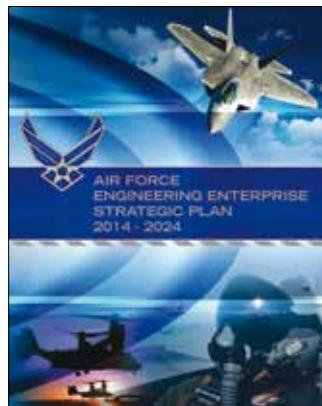


- Inject pivot points into acquisition allowing for programs to change direction based upon advances in technology, changes in threat environment, and the ever-present budget issues.
- Increase experimentation, both virtual and live, to allow for multidisciplinary teams to evolve concepts prior to committing to a development program. This is what our senior leaders expect. When they demand this type of engineering rigor, the culture change throughout our enterprise will take hold.

Flowing from this strategic guidance are many initiatives. Digital engineering is driven by the Deputy Assistant Secretary of Defense for Science and Engineering, defining the requirements to institutionalize digital engineering across the DoD—including data, tools and required training. In BBP 3.0, USD(AT&L) Frank Kendall challenged the Services to “strengthen organic engineering capability.” In order to manage risk associated with the execution of our programs and maintain our technical superiority, Kendall said that the technical workforce requires the right training, data, physics-based tools and facilities. Owning the technical baseline is one of the five priorities of the Assistant Secretary of the Air Force (Acquisition) challenging the acquisition enterprise and engineers to technically understand their system and ensure we are better informed decision makers and can go toe-to-toe with our industry counterparts.

Cost Capability Analysis (CCA) is a direct result of our senior leadership realizing that they were not demanding technical

Advanced manufacturing, including AM, is outpacing our ability to incorporate the new capabilities. These game-changing technologies have the potential to allow the reclamation of parts that previously were considered irreparable; drastically reduce part lead time from years to just hours or days; and allow the production of repair parts at deployed locations. These technologies present us with several challenges, ranging from policy to processes.



Condition Based Maintenance plus Prognostication (CBM+P) will significantly reduce operations and support costs by allowing a continuous understanding of the condition of our systems and bringing them in when they are needed. Finally, the *Air Force Engineering Enterprise Strategic Plan 2014-2024* is the strategic vision for transforming Air Force engineering. The Air Force Engineering Enterprise Executive Council (EEEC) is the body executing the *Air Force Engineering Enterprise Strategic Plan*. The EEEC is the framework for how Air Force engineering will bring all these initiatives together in a cogent manner, reduce duplication of effort and seek and exploit synergies.

The EEEC has four priorities:

- Refine engineering roles, responsibilities and policy.
- Enable high-quality decisions and seamless communication.
- Improve technical information management and standardization.
- Improve technical workforce and address competency gaps.

In order to achieve our senior leaders' vision, the acquisition community must institutionalize the digital thread throughout the enterprise. This requires access to the right data, the right tools and the right training.

rigor in order to ensure that our systems deliver the needed capability at a sustainable cost. CCA is a methodology to fully investigate the systems trade space, evaluate the performance requirements for mission effectiveness and determine the cost for each solution. This allows the decision maker to see the “knee in the curve” and determine the best solution for the Air Force and prevent the “exquisite solution.”

Below those four priorities are 10 goals and 57 objectives. Over the last 2 years, the EEEC has closed 16 of those 57 objectives. This 10-year plan and governing body is producing results.

The digital thread is the key enabler for achieving all these initiatives and is defined as an extensible, configurable and component enterprise-level analytical framework that seam-

lessly expedites the controlled interplay of authoritative technical data, software, information and knowledge in the enterprise data-information-knowledge systems, based on the digital system model template. This is done to inform decision makers throughout a system's life cycle by providing the capability to access, integrate and transform disparate data into actionable information. The digital thread is the method to manage the Digital System Model throughout the life cycle;

The right technical data are just parts of the digital thread. The right technical data must be managed throughout the life cycle. The Air Force engineering and logistics communities are developing the Product Life-cycle Management (PLM) Capability Initiative (CI) as the backbone of the digital thread. PLM-CI provides the Air Force with a single comprehensive enterprise capability to manage all program data and business processes from gap identification through disposal.



Our senior leaders have provided a future vision. The engineering community has defined our minimum requirements of access to the right data, right tools and right training, and is in the process of providing an infrastructure and capability to manage our program data.

from conceptual design, to "as designed," "as built" and "as maintained." The digital thread provides you the information necessary to:

- **BBP 3.0—Strengthen Organic Engineering Capability:** There is no reason to do this if there is no digital thread to organically evaluate.
- **Own the Technical Baseline:** We will not become better-informed buyers or be able to go toe-to-toe with our industry counterparts if there is no digital thread to organically evaluate.
- **Take advantage of AM:** All advanced manufacturing techniques and especially AM require the digital thread for implementation.
- **Implement Live-Virtual-Constructive Modeling and Simulation:** This requires verified and validated models that can be generated only by applying the right physics-based engineering tools to the digital thread.
- **Reap the benefits of CBM+P:** It is not possible to predict system condition without a digital thread to organically evaluate.
- **Accomplish CCA:** We cannot organically perform system of systems cost capability trades without a digital thread.
- **Acquisition Pivot Points:** We cannot deliver high-quality decision support and cost-effective experimentation to senior Air Force leaders without the digital thread.

The bottom line: In order to achieve our senior leaders' vision, the acquisition community must institutionalize the digital thread throughout the enterprise. This requires access to the right data, the right tools and the right training.

Our senior leaders have provided a future vision. The engineering community has defined our minimum requirements of access to the right data, right tools and right training, and is in the process of providing an infrastructure and capability to manage our program data. These are great steps in the right direction. We now are embarking on the next phase.

- What are the right data and how do we specify that in a contract?
- How do we incentivize collaboration and protect intellectual property?
- What are the right engineering tools and how are they accessed?
- What tools are needed on the desktop and in an engineering lab with high-powered work stations?
- What competency gaps exist and how will we grow our workforce to fill those gaps?

These critical questions are now being addressed in the Air Force Engineering Enterprise with our first spiral due by September 2016.

This is the perfect time to embrace a fundamental culture change and recapture organic engineering excellence. All Air Force strategic guidance fully supports this technical vision enabled by the digital thread. The Engineering Enterprise is producing actionable results, but we can't do this alone. We need your help in our efforts to define the right data, the right tools and the right training.

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